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Compaction – 2023 (114)

Proficiency Testing Program Report

Accredited for compliance with ISO/IEC 17043

Report

This report is available on the LabSmart Services website. The issue of this proficiency report was authorised by Jeffrey Mulholland, General Manager, LabSmart Services, in July 2023.

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Program Coordinator

The program coordinator for this program was Jeffrey Mulholland, LabSmart Services.

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Please note that any technical questions regarding this program are to be directed to the program coordinator.

Z-scores Summary

A z-scores summary for this program was issued in June 2023. This technical report supersedes the z-scores summary.

Accredited Proficiency Testing Provider

LabSmart Services is accredited by NATA to **ISO/IEC 17043,** Conformity assessment – General requirements for proficiency testing. Accreditation number 20650. The accreditation provides additional assurance to participants of the quality and importance we place on our proficiency testing programs.

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Amendment History

Reports may be downloaded from the LabSmart Services website.
Version 1 – Issued 24 July 2023

Contents

1. Program Aim

This proficiency testing program was conducted over March/April 2023 with 64 participants throughout Australia. The program involved the performance of the following tests.

- Standard Maximum Dry Density (MDD)
- Standard Optimum Moisture Content (OMC)

AS 1289.5.1.1 (2017) was the preferred testing method, but other equivalent methods were accepted.

Each participant's performance is statistically assessed and used as a measure of their competency relative to all other participants. The program provides feedback and confidence to participants and the industry regarding the competency of laboratories to perform these tests.

Details relating to the design and conduct of the program may be found under Section 5.

2. Performance

2.1. Identified Outliers

Overall, a satisfactory level of testing was achieved; out of the 59 participants that returned results for this report, only 3 were identified as outliers (approximately 5%).

Participants test results are tabulated in section 4, along with the robust statistics and a z-score graph. The z-score indicates how far away a participant is from the program's median value. A z-score of zero indicates a strong consensus with respect to all other participants and represents a very good outcome. The z-score graph gives a quick visual indication of how a result compares to others in the program.

Outliers are classified as z-scores where the z-score value is greater than 3 or less than -3. It is recommended that participants with outliers investigate their performance of the test. Participants with outliers are detailed in Table 1.

Those participants with z-scores greater than 2 or less than -2 may wish to review their testing methodology. Only those approaching 3 (outside ± 2.75) have been specifically identified in Table 1 as feedback.

More detail on the robust statistics used can be found in section 5.

Technical comment and feedback in section 3 is provided to assist participants in investigating and reviewing their results, as well as for those seeking to improve their testing performance.

Table 1: Identified outliers

Test	Investigate	Review*
Maximum Dry Density (MDD)	**U2, J4, D7**	**-**
Optimum Moisture Content (OMC)	**U2, J4**	**-**

2.2. Program Summary

There were 64 participants that applied for this proficiency testing program. Of these 64 participants, only 59 returned results in time to be included in the final report.

Of these 59 participants, 56 participants (approximately 5%) were found to have performed well in this program. The spread of MDD and OMC results aligned with previous programs.

Laboratories need to ensure that graphs are checked to be accurate and appropriate before issuing results. Laboratories should consider plotting air voids on compaction graphs and check that air voids, when plotted, are meaningful. Attention to the spread of compaction points, where two on the dry leg and two on the wet leg is ideal, will result in greater accuracy of testing.

Table 2 summarises the results obtained: Normalized IQR values approximate standard deviations.

Table 2: Summary Statistics

Statistic	MDD	OMC
	t/m^3	%
Number of participants	59	59
Median	2.073	10.0
Normalized IQR	0.024	0.6
CV (%)	1.2	5.9
Min*	2.011	8.8
Max*	2.128	11.1
Range*	0.117	2.3

*Minimum, Maximum and Range are calculated with outliers excluded

This proficiency testing program had a satisfactory outcome and is within industry expectations. The proficiency program was a useful exercise, allowing participants to have greater confidence in their results while for others providing an opportunity to improve their competency with respect to the test methods.

3. Technical Comment

3.1. Test Methodology

Participants were requested to provide additional details about the testing performed. These details were used to help analyse the proficiency program results. Also, the information can help with the investigation of outliers arising from the program. See section 6 for participant responses.

All participants indicated that they nominated the testing methods used for determining MDD and OMC as AS 1289.5.1.1. All participants also reported using AS 1289.2.1.1 for their determination of moisture. Additionally, all participants stated they used an ‘A’ sized mould, and the majority of participants reported using hand compaction, with only one participant using a mechanical compactor.

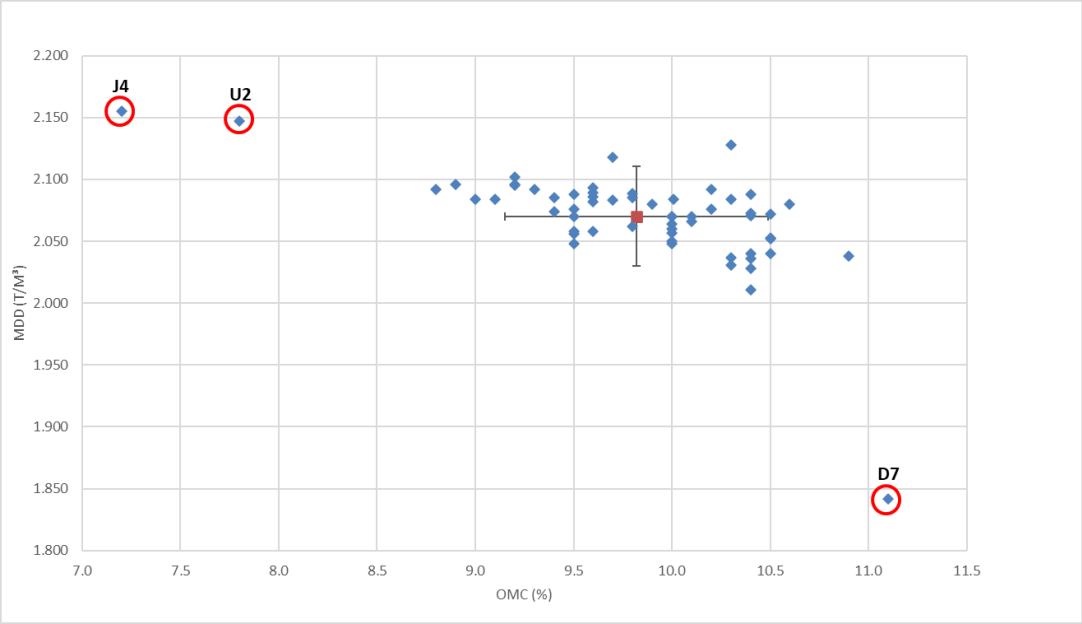
3.2. Soil Curing

Participants used a broad range of curing times ranging from 0.5 to 187 hours; see section 6 for more details. The material needs to be cured in such a manner as to ensure moisture is homogeneous throughout. AS 1289.5.1.1 gives specific minimum curing times based on the sample’s liquid limit, along with its deviation from OMC in its pre-prepared condition.

3.3. Maximum Dry Density (MDD) & Optimum Moisture Content (OMC)

Overall the spread of results for this program was acceptable; Graph 1 shows a plot of the submitted MDD vs OMC results for all participants. Only participants identified as an outlier have been noted on the graph.

Graph 1: Plot of participant MDD vs OMC results with outliers shown.



*The cross shows the variation at 1 s.d for MDD and OMC.

Discussion of Outliers

D7

Since the release of the z-score summary, participant **D7** has contacted LabSmart Services reporting that they have identified the issue. It would appear that a balance was not zeroed, resulting in an error in the final result.

J4 & U2

Participants **J4** & **U2** have similar results, having higher density and lower moisture. It is possible that both participants undertook modified compaction; however, this is not supported by the supplied information and can not be confirmed. Should these participants wish to contact LabSmart Services, we would happily help them assess the matter.

3.4. Graphing

This proficiency program specifically requested graphs to be submitted. All but 11 participants returned their graphs with their result log sheets. All but 2 participants used the graphing via computer-based software.

The test method indicates that a graph must be prepared to derive the OMC and MDD. Graphing the results is also the most practical approach in assessing the correct performance of this test and the reliability of the results obtained.

Unfortunately, the test method does not explicitly define the derivation of the graph or other essential aspects pertinent to the accuracy of this test. For example, it does not define when a result should be rejected.

In reviewing participant results, it did appear that, on average, if a single wet point was ‘out’, it could throw out the curve and, ultimately, the OMC/MDD obtained. If the same point was used to estimate the voids line, then this too could be thrown ‘out’.

Detailed feedback on graphing has been provided for past programs, but with many now using ‘software-based’ systems, the graphs provided are too small to review. However, laboratories may be able to enlarge graphs during the checking process. Graphs that are produced need to be reviewed as there is still an element of judgement involved and the chance that the software used has not produced the best outcome.

As a final note, some participants in this program have inadvertently changed the scale of the density and moisture axis used, giving a ‘better looking’ graph visually. Caution should be exercised, as this can be misleading. Those with outliers have raw data meeting the test method, but as explained in section 3.6.2, the choice of test points can lead to more significant variation in results.

Ultimately, Graphs need to be ‘fit for purpose’. Many laboratories need to keep working towards this.

3.5 Rounding

In some programs, the rounding approach used in standards can affect the variation observed (i.e. 0.01 for MDD and 0.5 for OMC).

For this program, we requested that participants not only submit unrounded results but, in the case of MDD, report to an additional significant figure. To ensure this didn't affect the program, LabSmart applied rounding to the submitted results and undertook the same analysis.

Table 3 Summary statistics comparing unrounded and rounded test results

Statistic	Unrounded		Rounded	
	MDD	OMC	MDD	OMC
	t/m^3	%	t/m^3	%
Number of participants	59	59	59	59
Median	2.073	10.0	2.07	10.0
Normalized IQR	0.024	0.6	0.02	0.74
CV (%)	1.2	5.9	1.1	7.4
Min*	2.011	8.8	2.10	8.0
Max*	2.128	11.1	2.13	11.0
Range*	0.117	2.3	0.12	3.0

*Minimum, Maximum and Range are calculated with outliers excluded

Table 3 shows the outcome of LabSmart's rounding. In this program, the effect was negligible.

3.6 General Discussion

3.6.1. Graphing

The compaction graph gives a visualisation of the test results. It is useful as a quick means of determining how well the test has been performed. This is conveyed through the “fit” of the curve to the points and spacing of the compaction/moisture data points. An “air voids line” can be a very useful addition.

The air voids line slope and y-intercept is determined by the soil particle density (See Graph 2). It is important to note that it curves. The soil particle density may have been determined experimentally or as approximated via the ‘Note’ under clause 6(d) of AS 1289.5.1.1.

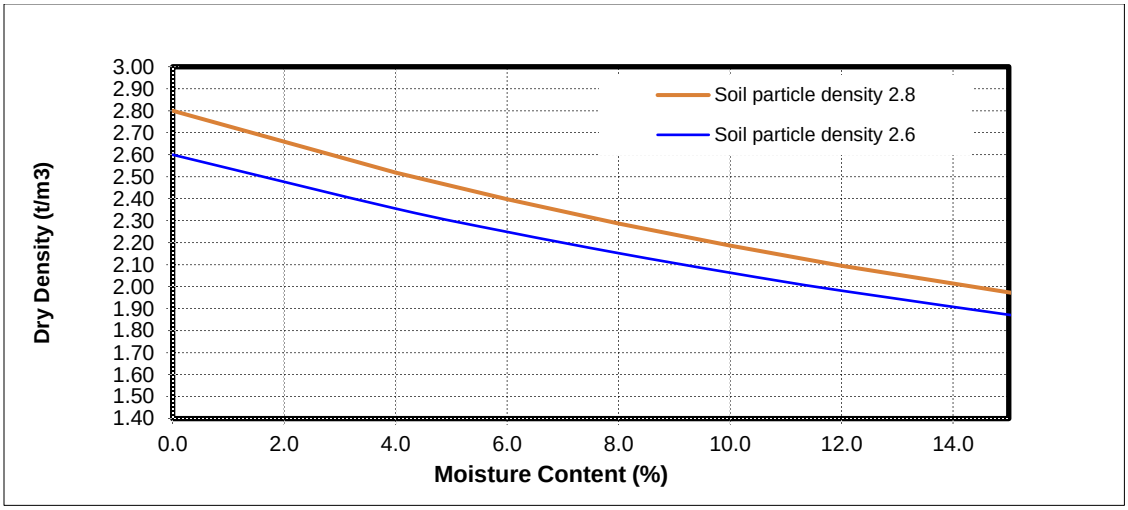
Soil particle density = 1 / [{(100 x (1 - (A/100))) - (B x C)} / (B*100)]

A = 0% Air Voids

B = Dry density of the wettest compaction point

C = Moisture at wettest compaction point plus 1%

Graph 2: Zero Air Voids



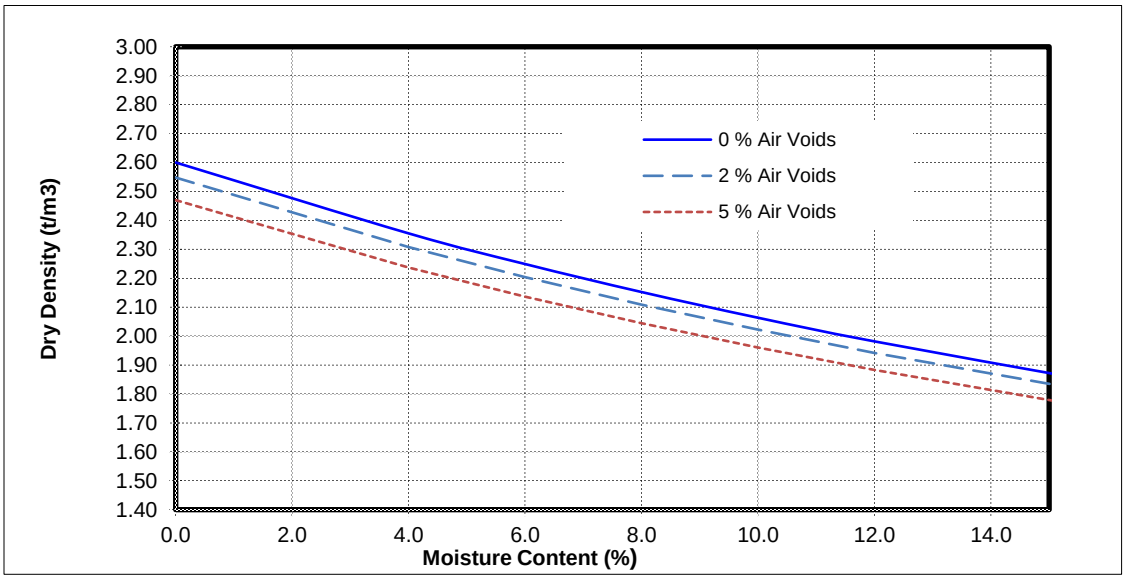
The test method note indicates that a 2% void line when plotted using this particle density should lie close to the compaction curve produced.

Void lines can be plotted at various amounts of entrapped air (Graph 3). Often 0 %, 2% or 5 % air void lines are useful.

The ‘wet leg’ of a compaction curve should run approximately parallel to the 0 % air void line. The compaction curve plotted must also lie to the left of the 0% air void line. The wet leg of the plotted curve should match the wet leg in slope (i.e. match the voids line). Compaction curves not corresponding to this should be reviewed. However, the curve should pass through the ‘wet’ data point if hand plotted at the expense of running parallel to the void line.

Many laboratories plot one or more air void lines using an assumed particle density. This may not convey the information needed to interpret the plotted results fully.

Graph 3: Air Voids - Soil Particle Density of 2.60



Soil particle densities generally lie between 2.6 and 2.8. The use of the equation, as noted in the test method, gives a more meaningful 2 % air void line.

It is recommended that laboratories consider showing air void lines. The air void line should be identified, and the particle density used indicated.

As to the graphs ‘fit-for-purpose’, it is clear many of the submitted graphs could be improved, but, it is up to laboratories to determine what best suits both their needs and those of their clients.

Participants without any void line(s) on their graphs are encouraged to consider adding these in the future.

3.6.2. Test Method

There are various road authority test methods for this test in use across Australia. The following comments, however, are related only to the AS 1289.5.1.1 method.

Part of proficiency testing programs is a need to discuss aspects of the test that can contribute to the overall variation. It does not mean the test method needs to change, only that it is important for laboratories to know which aspects of the test, if not performed well, could add to the variability of the outcome.

The need to change the test method only arises if the accuracy and variability in the test results are not within the expected range.

One aspect of the test that contributes significantly to the variation is the graphing approach used and the moisture points selected for compaction. With more laboratories using mathematical approaches to determine the OMC/MDD, the variation has reduced compared to using hand-drawn graphs.

Even though test results are rounded (i.e. OMC to 0.5 and MDD to 0.01), it is still important to test as accurately as possible. In doing so, despite the rounding employed it will lead to better reproducibility between laboratories as well as where the results are used elsewhere, such as in the CBR test.

Some of the results submitted for this program had ‘rogue data’ points that affected the OMC/MDD result. There is no industry-recognised approach to dealing with these.

Better definition of the mathematical approach to be used and specifying where data must fall on the curve would decrease testing variation between laboratories.

Currently, the test method allows the following:

1. Two points on the dry side of OMC/MDD and two on the wet side.
2. Three points on the dry side of OMC/MDD and one on the wet side.
3. Two points on the dry side of OMC/MDD, one at the apex and one on the wet side.

Approach 1 above is optimal; the other approaches (2 & 3) are more likely to show more variation because any error with the single point on the apex or wet leg dramatically affects the curve and, therefore, the determined MDD & OMC.

There is also a strong possibility that if different mathematics is used to fit a regression curve to the data, then there could be a variation depending on the approach used.

4. Statistics: Z-Score & Graph

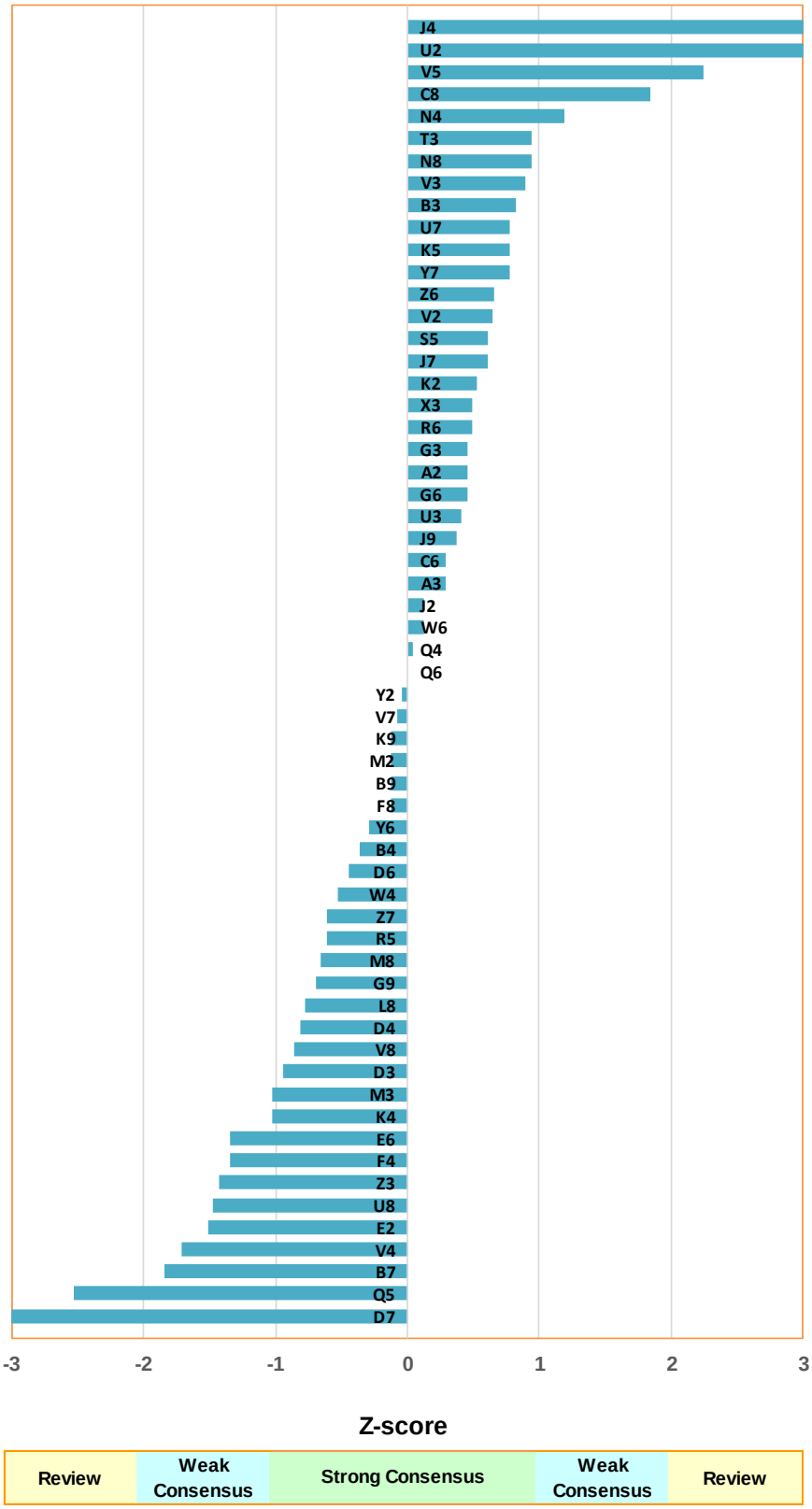
Maximum Dry Density: Z - Scores

Code	Test Result t/m³	Z Score	Code	Test Result t/m³	Z Score	Code	Test Result t/m³	Z Score
U2	2.147	**3.02** #	L8	2.054	-0.78	J7	2.088	0.61
J4	2.155	**3.35** #	Q4	2.074	0.04	M8	2.057	-0.65
M3	2.048	-1.02	Q5	2.011	-2.53	T8		
U7	2.092	0.78	V8	2.052	-0.86	J3		
G3	2.084	0.45	D7	1.842	**-9.44** #	P2		
B4	2.064	-0.37	J9	2.082	0.37	T6		
V5	2.128	2.25	D6	2.062	-0.45	V3	2.095	0.90
C8	2.118	1.84	T3	2.096	0.94	V2	2.0887	0.64
J2	2.076	0.12	V7	2.071	-0.08	V4	2.031	-1.72
B7	2.028	-1.84	F8	2.070	-0.12	E2	2.036	-1.51
A2	2.084	0.45	Y2	2.072	-0.04	K4	2.048	-1.02
D4	2.053	-0.82	E6	2.040	-1.35	K6		
W6	2.076	0.12	K5	2.092	0.78			
G6	2.084	0.45	Q6	2.073	0.00			
R6	2.085	0.49	N4	2.102	1.19			
W4	2.060	-0.53	Z6	2.089	0.65			
K9	2.07	-0.12	Z3	2.038	-1.43			
K2	2.086	0.53	C6	2.080	0.29			
M2	2.07	-0.12	Y7	2.092	0.78			
B9	2.07	-0.12	N8	2.096	0.94			
B3	2.093	0.82	Z7	2.058	-0.61			
D3	2.05	-0.94	U8	2.037	-1.47			
Y6	2.066	-0.29	A3	2.080	0.29			
S5	2.088	0.61	R5	2.058	-0.61			
U3	2.083	0.41	G9	2.056	-0.69			
X3	2.0851	0.49	F4	2.040	-1.35			

Statistic	*Value*	
Number of results	**59**	
Median	**2.073**	
Median MU	**0.004**	
First Quartile	**2.055**	
Third Quartile	**2.088**	
IQR	**0.033**	
Normalised IQR	**0.024**	
CV (%)	**1.2**	
Minimum	**2.011**	(1.842)
Maximum	**2.128**	(2.155)
Range	**0.117**	(0.310)

Note: A # indicates an outlier where the z-score obtained is either greater then 3 or less than -3. Codes for all participates are shown. The results column shows a blank entry or 'NR' for those participants that did not submit a result for this test. Results in **green** have been calculated by the program coordinator. Minimum, Maximum and Range are calculated with outliers excluded, those in brackets include outliers.

Maximum Dry Density: Z - Score Graph



Optimum Moisture Content: Z - Scores

Code	Test Result %	Z Score
U2	7.8	**-3.71 #**
J4	7.2	**-4.72 #**
M3	9.5	-0.84
U7	8.8	-2.02
G3	9.1	-1.52
B4	10.0	0.00
V5	10.3	0.51
C8	9.7	-0.51
J2	10.2	0.34
B7	10.4	0.67
A2	10.3	0.51
D4	10.5	0.84
W6	9.5	-0.84
G6	9.0	-1.69
R6	9.4	-1.01
W4	10.0	0.00
K9	9.5	-0.84
K2	9.6	-0.67
M2	10.1	0.17
B9	10.0	0.00
B3	9.6	-0.67
D3	10.0	0.00
Y6	10.1	0.17
S5	10.4	0.67
U3	9.7	-0.51
X3	9.8	-0.34

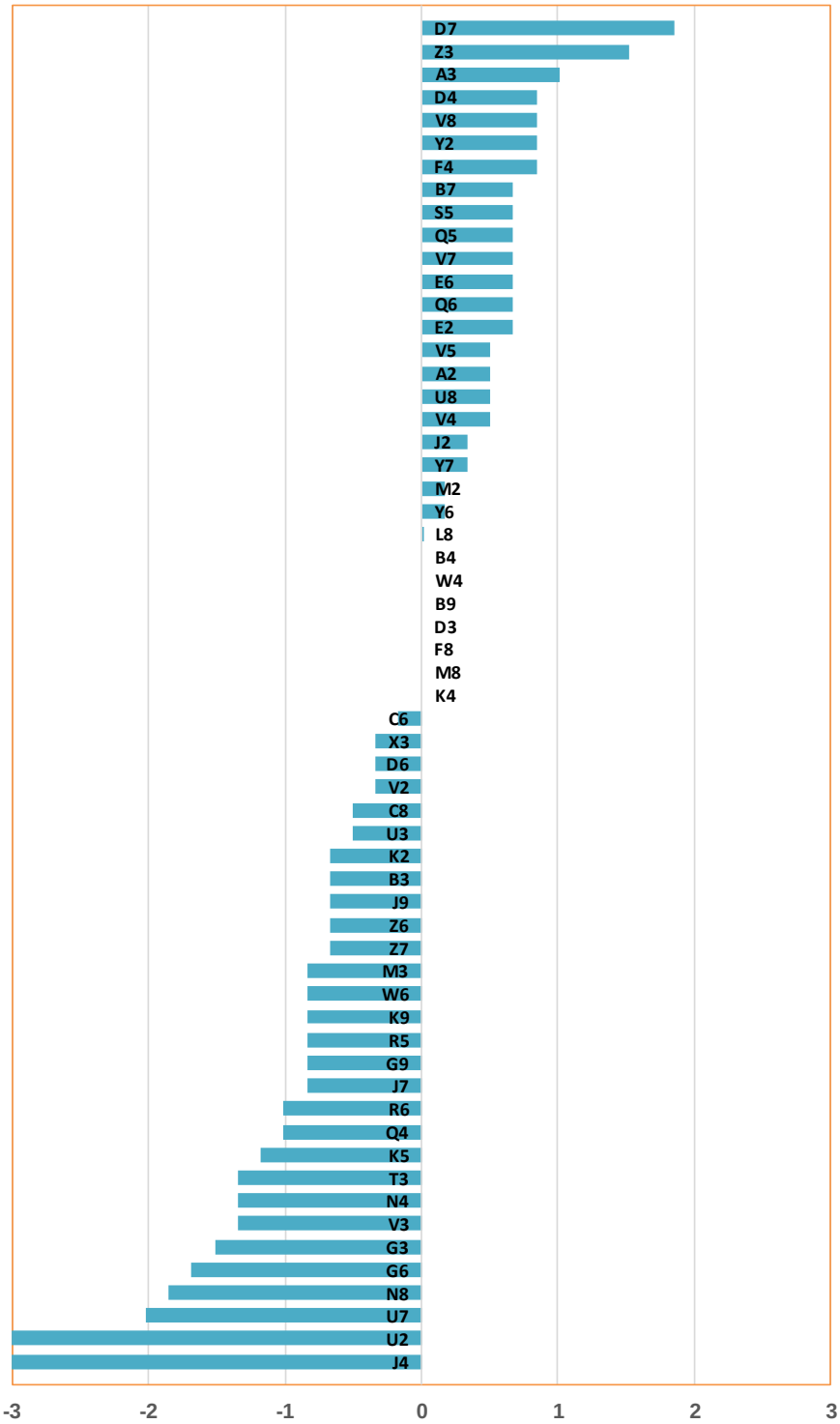
Code	Test Result %	Z Score
L8	10.01	0.02
Q4	9.4	-1.01
Q5	10.4	0.67
V8	10.5	0.84
D7	11.1	1.85
J9	9.6	-0.67
D6	9.8	-0.34
T3	9.2	-1.35
V7	10.4	0.67
F8	10.0	0.00
Y2	10.5	0.84
E6	10.4	0.67
K5	9.3	-1.18
Q6	10.4	0.67
N4	9.2	-1.35
Z6	9.6	-0.67
Z3	10.9	1.52
C6	9.9	-0.17
Y7	10.2	0.34
N8	8.9	-1.85
Z7	9.6	-0.67
U8	10.3	0.51
A3	10.6	1.01
R5	9.5	-0.84
G9	9.5	-0.84
F4	10.5	0.84

Code	Test Result %	Z Score
J7	9.5	-0.84
M8	10.0	0.00
T8		
J3		
P2		
T6		
V3	9.2	-1.35
V2	9.8	-0.34
V4	10.3	0.51
E2	10.4	0.67
K4	10.0	0.00
K6		

Statistic	*Value*	
Number of results	**59**	
Median	**10.0**	
Median MU	**0.10**	
First Quartile	**9.5**	
Third Quartile	**10.3**	
IQR	**0.8**	
Normalised IQR	**0.6**	
CV (%)	**5.9**	
Minimum	**8.8**	(7.2)
Maximum	**11.1**	(11.1)
Range	**2.3**	(3.9)

Note: A # indicates an outlier where the z-score obtained is either greater then 3 or less than -3. Codes for all participates are shown. The results column shows a blank entry or 'NR' for those participants that did not submit a result for this test. Results in **green** have been calculated by the program coordinator. Minimum, Maximum and Range are calculated with outliers excluded, those in brackets include outliers.

Optimum Moisture Content: Z - Score Graph



5. Program Information

5.1. Z-score summary

This proficiency program was conducted in March/April 2023. A ‘Z-score Summary’ was issued on the 23rd of May, 2023. The ‘Z-score Summary’ was then reissued on the 6th of June 2023 to amend some missing data.

A copy of both was e-mailed to all participants who submitted results as well as being available on the LabSmart Services website. The summary is intended as an early indicator of participant performance. This program report supersedes the z-score summary. Further information can be found in section 5.9 ‘Statistics’.

5.2. Program Design

5.2.1. Design

Part of the design of each program involves gathering the right information. The correct analysis of the data collected then allows feedback to be given and enables participants to improve in their performance on this test.

In past programs, LabSmart used to supply a second section; in this section, we would normally supply a set of compaction data points and ask participants to recalculate a result. It was an excellent way to assess/compare different participant graphing techniques. However, as many companies move towards similar online services, the spread of results have become smaller and smaller, and it has now reached a point where the statistics have become unrealistic as compared to the standard requirements.

Other considerations involving the design of the program are detailed below.

5.2.2. Selection of material used in the program

The test in this proficiency program is operator skill/experience-dependent. In addition, certain types of soils require more knowledge to obtain consistent results than others.

Different materials are selected for each program to mirror the range of materials encountered in practice. This program provides a sample that gives results in the range that would be commonly tested by laboratories.

It is expected that the level of experience/skill needed to perform these tests will present a reasonable assessment of the overall competency of the tester and industry performance.

5.2.3. Role of proficiency testing

The determination of outliers is an important task of this proficiency program. A secondary function is to provide feedback that can help those with outliers identify possible areas to investigate as well as assist all participants in improving.

In addition to the statistics, proficiency programs often obtain other information not normally available. It allows for a better understanding of the testing and can provide information that can lead to improvements in the testing process or test method.

Proficiency testing enables participants to measure competency against others. It is also a measure of staff performance and the equipment used. Apart from ‘measurement uncertainty’, it is the most useful tool a laboratory has in better understanding the performance of a test.

5.2.4. Participant assessment

The assessment of each participant is based on a z-score that is related to the program consensus value (median). This is used to determine any statistical outliers. Compliance with proficiency program requirements, including the correct calculation of results and adherence to program and test method requirements, may also be used as part of the assessment process. Participants may also be asked to investigate any discrepancies detected with the paperwork submitted.

5.2.5. Reporting of results - Significant figures

The number of decimal places (significant figures) reported for a test has a bearing on the statistical analysis and therefore, the interpretation of the results. There is a need to strike a balance between what is desirable from a statistical viewpoint while recognising how the results are used in practice.

Too few decimal places (e.g. due to rounding) can cause an increase in the observed spread of results. Increasing the number of decimal places (with respect to normal reporting) can distort the observed spread of results compared to that encountered in actual practice. Large numbers of similar, rounded results can also cause a distortion in the analysis.

For example, rounding to 0.5 % means that any number between 10.75 and 11.25 will be 11.0%. If the largest value is 10.75 in a set of results, it is pushed out to 11.0 through rounding. Rounded results are useful from “an end-user” perspective but are not as useful when considering laboratory performance. The test method acknowledges additional decimal places may be used for statistical purposes.

For this program, it was decided that the benefits of using additional decimal places would complement the aim of the proficiency program.

Participants results were analysed as received regardless of whether there were more, or less significant figures used other than the number requested by the program.

5.2.6. Additional information requested

This program requested additional information detailed in section 6, which is not usually reported. The additional information is, however, consistent with the performance of the test and the records; the test method requires laboratories to maintain. The additional information is used to interpret participant’s performance and assist with providing technical comment, including feedback on outliers and possible participant improvements.

5.2.7. Data checks

As often observed, ‘operator errors’ can occur in the result calculation process. Not all the participant’s results were verified as reasonable, only those with outliers. The spacing of moisture steps was checked as per the test method. Checks, however, are only as accurate as the raw data supplied by each participant. These checks also help ensure that the data is comparable. Any inconsistencies identified during this process are identified as possible feedback for participant improvement. In some cases, inconsistencies identified may need to be investigated by participants.

5.2.8. Confidentiality

All information, including test results, are treated confidentially. The proficiency testing report does not identify either companies or individuals. Each participant is issued a unique identifying code during enrolment that is used in the report to ensure confidentiality of performance.

5.3. Sample Preparation

Samples for the program were drawn and packaged from a single, well-mixed lot. Samples were laid out in the order prepared; then, ten samples were selected at equal intervals. These ten samples were used for homogeneity testing.

Each participant received randomly drawn samples from the remainder. A unique participation code was assigned to each sample. Each sample was placed in a plastic bag, sealed, labelled with the program name and packed into a sturdy box prior to dispatch.

5.4. Packaging and Instructions

Each participant received one sealed plastic bag containing approximately 16kg of soil. Participants were instructed to test per the nominated test method and report to the accuracy indicated on the ‘results log’ sheet.

See ‘Appendix A’ for a copy of the instructions issued to participants and ‘Appendix B’ for the Results Log sheet supplied.

5.5. Quarantine

Samples sent to Western Australia are subject to quarantine regulations that require treatment of the soil before importation. Samples sent to WA are heat-treated, and compliance certificates are enclosed within sample packaging. Where applicable, further instructions regarding the preparation or handling of the sample may be included.

Additionally, LabSmart undertook comparative testing between the Homogeneity Results (10 Samples) and five additional Heat Treated samples. The 5 Heat Treated samples fell within the spread of Homogeneity Results.

5.6. Sample dispatch

Samples were dispatched to participants on the 11th of April, 2023, via Pack and Send. Dispatched samples are tracked from dispatch to delivery to each participant by LabSmart Services.

5.7. Homogeneity Testing

Samples for homogeneity testing were packed in the same way as those for participants. Ten samples were selected at equal intervals. To approximate the same conditions as participants, the same instructions were given to the laboratory performing the homogeneity testing.

The homogeneity data showed a slight variation indicative of the sample being homogenous and, therefore, suitable for this program. A summary of these results can be seen in Table 4.

Table 4: Homogeneity Results

Sample Code	MDD kg/m3	OMC %
H1	2.031	9.7
H2	2.015	10.2
H3	2.035	10.4
H4	2.037	9.7
H5	2.040	9.7
H6	2.029	9.7
H7	2.027	10.3
H8	2.024	10.5
H9	2.012	10.1
H10	2.048	9.7
Average	2.030	10.0
Standard Deviation	0.011	0.33
Minimum	2.012	9.7
Maximum	2.048	10.5
Range	0.036	0.8
Coefficient of Variation (%)	0.5	3.33

5.8. Participation

64 participants entered the program, with a total of 59 participants returning results for inclusion in this report. The nominated date for participants to return their results was the 5th of May, 2023.

5.9. Statistics

Z-Scores were calculated for each test and used to assess the variability of each participant relative to the consensus median. A corresponding z-score graph was produced for each test.

The use of median and quartiles reduces the effect that outliers have on the statistics and other influences. As a consequence, z-scores provide a more realistic or robust method of Assessment.

Some results were reported by participants to more decimal places than requested as part of the proficiency program and by others to fewer decimal places. In all instances, test results have been used as submitted by participants.

A z-score is one way of measuring the degree of consensus with respect to the grouped test results. The z-scores in this report approximate standard deviations. For each test, a z-score graph is shown. Use the graph to visually check statistically how you compare to other participants.

The following bar is shown at the bottom of each graph. This helps to visualise where each participant's result falls quickly.

Figure 1: Z-score interpretation bar

For example:

- A **strong consensus** (i.e. agreement) means that your test result is close i.e. within 1 standard deviation of the median.

- A **weak consensus** means that your test result is satisfactory and is within 2 standard deviations of the median.

- If you have obtained a test result that is outside 2 standard deviations, then it may be worth **reviewing** your testing processes to ensure that all aspects are satisfactory. Only those obtaining a z-score approaching 3 (I.e. outside 2.75 range) have been highlighted in the report for review.

If you have obtained a test result that is outside 3 standard deviations, then you will need to investigate your testing processes to ensure that all aspects are satisfactory.

Further details on the statistics used in this proficiency program can be obtained from LabSmart Services or download the 'Participant Guide' from the LabSmart Services website.

5.9.1. Z-score summary

A "Z-Scores Summary" is issued soon after most results are received. It gives participants early feedback as to any program outliers. The summary is usually available on the LabSmart Services website up until the final report is issued. The final report supersedes the z-score summary.

The final report contains detailed technical feedback regarding the performance of tests and revised z-scores. The inclusion of late results or corrections is at the discretion of the program coordinator. In some instances, this may change some of the z-scores slightly, but generally, the performance outcome remains the same. If there is any impact, it will be discussed in section 5.1 of the report.

5.9.2. Comparing statistics from one program to another

The statistics generated from one proficiency program are not usually comparable to those from another proficiency testing program. Only very general comparisons may be possible. The reason statistics from one program may not be compared to another is due to the range of variables that differ from one proficiency program to another.

These variables include:

- Type of material selected,
- The number of participants,
- Experience of participants,
- Test methodology variations,
- Equipment used,
- Test methods used,
- Experience of supervisors,
- Range of organisations involved.
- Program design and the statistics employed

The program outcome represents a ‘snapshot’ of the competency within the industry and hence provides an overview of the industry - The more participants involved in each program, the more representative the overview.

5.9.3. Measurement Uncertainty (MU)

The statistics detailed in this program do not replace laboratories' need to separately calculate measurement uncertainties associated with each test when required by the client or NATA. The proficiency program does give valuable information for calculating the MU and bench-marking the MU calculated.

5.9.4. Metrological traceability

The assigned median value used in this proficiency testing program is derived from participant performance and is not metrologically traceable.

5.10. Non-statistical Matters

One of the issues faced by proficiency testing providers is, what to do with an incorrect result even if its z-score is satisfactory. In many cases, they cannot be detected but still can have a significant impact on the statistics. This can cause biased (or unfair) outcomes for other participants.

To limit the effect that erroneous results may have on a program, additional information is requested to allow the main results to be recalculated. In some cases, results shown to be erroneous may be rejected for inclusion in the program. If the result does not add any statistical bias, it is left in the program.

The result, however, is incorrect even though it may have a satisfactory z-score. To highlight that the participant needs to investigate erroneous results, it is considered a ‘non-statistical’ matter.

This may also be applied to non-compliance to program requirements, e.g. incorrect reporting of results or incorrect partial calculations/data.

Non-statistical matters were not used as part of the assessment process for this program.

6. Summary of Participant's Results

Code	MDD Method	MC Method	Cure Time (hrs)	Mechanical Compaction	Mould Size Used
U2	1289.5.1.1	1289.2.1.1	51.2	no	a
J4	1289.5.1.1	1289.2.1.1	24.0	no	a
M3	1289.5.1.1	1289.2.1.1	187.5	no	a
U7	1289.5.1.1	1289.2.1.1	168	no	a
G3	1289.5.1.1	1289.2.1.1	2.0	no	a
B4	1289.5.1.1	1289.2.1.1	65	no	a
V5	1289.5.1.1	1289.2.1.1	24	no	a
C8	1289.5.1.1	1289.2.1.1	16	no	a
J2	1289.5.1.1	1289.2.1.1	24	no	a
B7	1289.5.1.1	1289.2.1.1	2	no	a
A2	1289.5.1.1	1289.2.1.1	48	yes	a
D4	1289.5.1.1	1289.2.1.1	48	no	a
W6	1289.5.1.1	1289.2.1.1	48	no	a
G6	1289.5.1.1	1289.2.1.1	48	no	a
R6	1289.5.1.1	1289.2.1.1	52	no	a
W4	1289.5.1.1	1289.2.1.1	2.0	no	a
K9	1289.5.1.1	1289.2.1.1	2.0	no	a
K2	1289.5.1.1	1289.2.1.1	2.0	no	a
M2	1289.5.1.1	1289.2.1.1	6	no	a
B9	1289.5.1.1	1289.2.1.1	2	no	a
B3	1289.5.1.1	1289.2.1.1	72	no	A
D3	1289.5.1.1	1289.2.1.1	5.5	no	a
Y6	1289.5.1.1	1289.2.1.1	93	no	a
S5	1289.5.1.1	1289.2.1.1	50	no	a
U3	1289.5.1.1	1289.2.1.1	2	no	a
X3	1289.5.1.1	1289.2.1.1	123.5	no	a
L8	1289.5.1.1	1289.2.1.1		no	a
Q4	1289.5.1.1	1289.2.1.1	6.5	no	a
Q5	1289.5.1.1	1289.2.1.1	96	no	a
V8	1289.5.1.1	1289.2.1.1	50.5	no	a
D7	1289.5.1.1	1289.2.1.1	49	no	a
J9	1289.5.1.1	1289.2.1.1	53	no	a

Code	MDD Method	MC Method	Cure Time (hrs)	Mechanical Compaction	Mould Size Used
D6	1289.5.1.1	1289.2.1.1	18	no	a
T3	1289.5.1.1	1289.2.1.1	3.0	no	a
V7	1289.5.1.1	1289.2.1.1	24	no	a
F8	1289.5.1.1	1289.2.1.1	2.0	no	a
Y2	1289.5.1.1	1289.2.1.1	0.5	no	a
E6	1289.5.1.1	1289.2.1.1	25	no	a
K5	1289.5.1.1	1289.2.1.1	2	no	a
Q6	1289.5.1.1	1289.2.1.1	48	no	a
N4	1289.5.1.1	1289.2.1.1	2.5	no	a
Z6	1289.5.1.1	1289.2.1.1	4.5	no	a
Z3	1289.5.1.1	1289.2.1.1	2	no	a
C6	1289.5.1.1	1289.2.1.1	4	no	a
Y7	1289.5.1.1	1289.2.1.1	26	no	a
N8	1289.5.1.1	1289.2.1.1	24	no	a
Z7	1289.5.1.1	1289.2.1.1	2	no	a
U8	1289.5.1.1	1289.2.1.1	6.5	no	a
A3	1289.5.1.1	1289.2.1.1	6	no	a
R5	1289.5.1.1	1289.2.1.1	28	no	a
G9	1289.5.1.1	1289.2.1.1	2.0	no	a
F4	1289.5.1.1	1289.2.1.1	2	no	a
J7	1289.5.1.1	1289.2.1.1	2	no	a
M8	1289.5.1.1	1289.2.1.1	125	no	a
T8	1289.5.1.1	1289.2.1.1			
J3	1289.5.1.1	1289.2.1.1			
P2	1289.5.1.1	1289.2.1.1			
T6	1289.5.1.1	1289.2.1.1			
V3	1289.5.1.1	1289.2.1.1	43	no	a
V2	1289.5.1.1	1289.2.1.1	2	no	a
V4	1289.5.1.1	1289.2.1.1	6	no	a
E2	1289.5.1.1	1289.2.1.1	4	no	a
K4	1289.5.1.1	1289.2.1.1	2	no	a
K6	1289.5.1.1	1289.2.1.1			

Appendix A: Instructions for testers

LabSmart Services

NATA

Soil Compaction Proficiency Testing Program 2023 (114)

INSTRUCTIONS FOR TESTERS

1. Please check that the package you have received contains the following:

   - Instructions (for tester)
   - Results Log
   - Approximately 18 kg soil sample sealed in a plastic bag.

Contact LabSmart Services on 0439 208 406 if the bag is damaged or any item is missing.

2. Please read and follow these instructions carefully. Examine the results log sheets.

3. Please do not discuss aspects of this program with other organisations or other staff within your own organisation who may also be testing a sample from this program. Confidentiality is important in order to ensure statistically valid measures of participant performance.

4. Due to segregation during transit, please ensure the sample is thoroughly **mixed** prior to starting. Ensure moisture is uniform throughout the sample.

5. AS 1289.5.1.1, 4 points is the preferred test method.

6. You may perform the test even if you are not NATA accredited for the test. The use of mechanical compaction is allowed.

7. Sieve the sample over the 19.0 mm sieve. Discard any material retained on the 19.0mm sieve. Thoroughly mix the material passing the 19.0mm sieve and use it for the compaction test. Check if the material needs to dry back before commencing the test.

8. Record all information and calculations as per the proficiency testing results log sheet and **to the accuracy shown on the results log sheet.** A greater reporting accuracy is required compared to that nominated by the standard. **Please forward the graph used.**

Please e-mail the "Results Log" to LabSmart Services by the 5th of May 2023
E-mail: info@labsmartservices.com.au

Thank you for participating in this proficiency program.

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Appendix B: Results Log

LabSmart Services

Soil Compaction Proficiency Testing Program – 2023 (114)

RESULTS LOG for xxxxxxxxxxxxxxxxxxxxx

Participation Code: xx

☞ Please E-mail (info@labsmartservices.com.au) the completed results log by:

5th May 2023

Date sample received:	
Condition of sample received:	
Tested by:	

Test	Report to:	Result	Method	
			Recommended	Tick or enter method used
Standard Maximum Dry Density (MDD)	Nearest 0.001 t/m^3		AS 1289.5.1.1	
Standard Optimum Moisture Content (OMC)	Nearest 0.1 %		AS 1289.5.1.1	
Method used to determine moisture			AS 1289.2.1.1	

Data used to construct curve	Dry Density	Moisture
	Report to Nearest 0.001 t/m^3	Report to Nearest 0.1 %
Sample 1		
Sample 2		
Sample 3		
Sample 4		

Additional test details	Report	Result		
Curing time used	Nearest ½ hr			
Has a mechanical compactor been used?	(Yes or No)			
Mould size used	A or B			
Number of blows used per compaction layer	Blows			

Page **1** of **2**

Please attach the graph used

COMMENTS:

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_____	_____	_____
Supervisor Name *(Please Print)*	**Signature**	**Date**

In signing the above, I acknowledge that the above results have been checked and are approved. I will also ensure that the results are kept confidential, both internal and external, to the laboratory until the final technical report covering this program has been issued.

Note:

Please retain the completed "Results Log" as this contains your participation code that will identify your results in the technical report. A copy of completed worksheets is also recommended to keep with the results log in your proficiency file.

Thank you for participating

Have a query? Contact LabSmart Services. Mobile: 0439 208 406

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